

25 said scan-deflection means having X-Y coordinates of deflection for area coverage at least within the perimeter of said [central area] limited field, adjustable means for angular selection of the orientation of the  
30 said coordinates to position one to the exclusion of the other of said coordinates in oriented [alignment with the] relation to the ascertained astigmatism axis of the [eye] cornea to be operated upon, and means including a microprocessor for establishing a series of different  
35 centrally related perimeter limits of generally rectangular-area scan within the perimeter of said [central area] limited field and for coordinating the operation of said scan-deflection means in a controlled program of limitation of one area scan within one perimeter limit  
40 before repeating such coordination within the next-successive perimeter limit in the series, the successively scanned areas being of varying width and symmetrical about a central axis aligned with said astigmatism axis, [said laser means including means for adjusting beam-exposure flux to a level at which resultant corneal-tissue  
45 ablation per unit time is to an ascertained elemental depth which is but a fraction of desired maximum depth of ablation into the stroma region of the cornea,] whereby ablative penetration to said maximum depth is the cumulative result of plural area scans of each of a succession of different but overlapping rectangular areas[.] , with astigmatism-reducing cornea-curvature correction.

C1  
Cont'd.  
5 Claim <sup>2</sup>2. (Amended) [Astigmatism apparatus] Apparatus according to claim <sup>1</sup>1, and including means for effectively limiting to the perimeter of said [central area] limited field the component of scan in said one-coordinate orientation.

3  
5 Claim <sup>3</sup>3. (Amended) [Sculpture apparatus for reduction of an ascertained astigmatic condition in the central area of the external surface of the cornea of an eye of a patient,] Apparatus for performing ophthalmological surgery to reduce an ascertained astigmatic condition by selective ablation of the anterior surface of the cornea with penetration into the stroma to achieve a volumetric removal of corneal tissue, said apparatus comprising laser means having a chassis and

10 producing an output beam in the ultraviolet portion of  
the electromagnetic spectrum and characterized by a  
spot which at eye impingement is small [compared to said  
area] in relation to the cornea to be operated upon,  
15 said laser means including means for adjusting beam-  
exposure flux to a level at which corneal-tissue ablation  
per unit time is to an ascertained elemental depth which  
is but a fraction of desired maximum depth into the stroma  
region, scan-deflection means positioned for deflection of  
said beam in a limited field about a central axis, [body-  
engageable] means for steadying [one eye of the patient]  
20 the cornea with respect to said chassis and with the  
central area of the cornea centered on the central axis  
of scan deflection of said beam, said scan-deflection  
means having two coordinates of deflection for area  
coverage within the perimeter of said [central area,]  
25 limited field, [said laser including means for adjusting  
beam-exposure flux to a level at which resultant corneal-  
tissue ablation per unit time is to an ascertained elemental  
depth which is but a fraction of desired maximum depth of  
ablation into the stroma region of the cornea,] and means  
30 including a microprocessor for coordinating the operation  
of said scan-deflection means in a controlled program of  
area coverage to establish greatest cumulative beam exposure  
along the alignment of the central axis of symmetry of the  
ascertained astigmatic condition, with cumulative beam  
35 exposure decreasing smoothly as a function of increasing  
lateral offset on both sides of said central axis of  
symmetry.

Add claims 25 to 28, as follows:

7-- 25. Apparatus for performing ophthalmological surgery  
to reduce an ascertained astigmatic condition by selective  
ablation of the anterior surface of the cornea with pene-  
tration into the stroma to achieve a volumetric removal of  
corneal tissue, said apparatus comprising laser means having  
5 a chassis and producing an output beam in the ultraviolet  
portion of the electromagnetic spectrum and characterized  
by a spot which at eye impingement is small in relation to  
the cornea to be operated upon, said laser means including

C2  
Cont'd.

10 means for adjusting beam-exposure flux to a level at  
which corneal-tissue ablation per unit time is to an  
ascertained elemental depth which is but a fraction of  
desired maximum depth into the stroma region, scan-  
deflection means positioned for deflection of said beam  
15 in a limited field about a central axis, means for  
steadying the cornea with respect to said chassis and  
with the central area of the cornea centered on the  
central axis of scan deflection of said beam, said scan-  
deflection means having X-Y coordinates of deflection  
20 for area coverage at least within the perimeter of said  
limited field, adjustable means for angular selection  
of the orientation of said coordinates to position one  
to the exclusion of the other of said coordinates in  
oriented relation to the ascertained astigmatism axis  
25 of the cornea to be operated upon, and control means  
with coordinating control connections to said scan-  
deflection means and to said laser for establishing a  
series of different centrally related perimeter limits  
of generally rectangular-area scan within the perimeter  
30 of said limited field and for coordinating the operation  
of said scan-deflection means in a controlled program of  
limitation of one area scan within one perimeter limit  
before repeating such coordination within the next-  
successive perimeter limit in the series, the successively  
35 scanned areas being of varying width and symmetrical about  
a central axis aligned with said astigmatism axis, whereby  
ablative penetration to said maximum depth is the cumulative  
result of plural area scans of each of a succession of  
different but overlapping rectangular areas, with  
40 astigmatism-reducing cornea-curvature correction.

4  
26. Apparatus for performing ophthalmological surgery  
to reduce an ascertained astigmatic condition by selective  
ablation of the anterior surface of the cornea with pene-  
tration into the stroma to achieve a volumetric removal of  
corneal tissue, said apparatus comprising laser means having  
5 a chassis and producing an output beam in the ultraviolet  
portion of the electromagnetic spectrum and characterized  
by a spot which at eye impingement is small, in relation  
to the cornea to be operated upon, said laser means including

10 means for adjusting beam-exposure flux to a level at which  
corneal-tissue ablation per unit time is to an ascertained  
elemental depth which is but a fraction of desired maximum  
depth into the stroma region, scan-deflection means positioned  
for deflection of said beam in a limited field about a  
15 central axis, means for steadying the cornea with respect  
to said chassis and with the central area of the cornea  
centered on the central axis of scan deflection of said  
beam, said scan-deflection means having two coordinates  
of deflection for area coverage within the perimeter of  
20 said limited field, and control means for coordinating  
the operation of said scan-deflection means in a controlled  
program of area coverage to establish greatest cumulative  
beam exposure along the alignment of the central axis of  
symmetry of the ascertained astigmatic condition, with  
25 cumulative beam exposure decreasing smoothly as a function  
of increasing lateral offset on both sides of said central  
axis of symmetry.

*C2 Cont'd.*

5. Apparatus for performing ophthalmological surgery  
by selective ablation of the anterior surface of the cornea  
with varied penetration up to a predetermined maximum pene-  
tration into the stroma to achieve a cylindrical astigmatism-  
5 reducing anterior-curvature change by volumetric removal of  
tissue within the optically functioning area of the cornea,  
said apparatus comprising: a laser producing a pulsed laser  
beam in the ultraviolet region of the electromagnetic spectrum;  
means for shaping, focusing and directing the beam toward the  
10 eye with an intensity to produce tissue penetration to a depth  
per pulsed exposure which is but a fraction of said predeter-  
mined maximum; said means including means for selectively first  
determining and controlling a first rectangular area of  
exposure to the extent of at least said fractional depth and  
15 thereafter determining and controlling a second and different  
rectangular area of exposure to the extent of at least said  
fractional depth, each of said rectangular areas being symmetri-  
cally disposed on opposite sides of one and the same meridian  
of the cornea and within the optically functioning area of  
20 the cornea, wherein said meridian is selectable for orientation